DIFFERENCES IN THE EFFECTS OF AEROBIC, RESISTANCE, AND COMBINATION EXERCISE TYPES WITH MODERATE-INTENSITY ON SERUM SEROTONIN LEVELS IN OBESE WOMEN

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Abstract

This study aims to compare the different effects of moderate-intensity exercise on serum serotonin levels in obese women aged 20-24 years with aerobic, resistance, and combination types of exercise intervention. This research is a field experimental with a pre-test post-test control group design to see an increase in serum serotonin levels. The intervention will be carried out chronically for four weeks. A total of 24 women who met the inclusion criteria were divided into four groups, namely control, aerobic, resistance, and combination groups and tested with moderate intensity exercise. Blood tests were taken before and after the exercise intervention were given to measure the changes in serum serotonin levels. The samples acquired were examined by SPSS version 16. The results of aerobic (2067.59±83.53 ng/mL to 2335.89±77.32 ng/mL), resistance (2067.59±123.99 ng/mL to 2513.57±173.04 ng/mL), and combination (2066.40±104.34 ng/mL to 2725.77±67.16 ng/ mL) exercise for four weeks with moderate intensity showed that the three groups experienced an increase in serum serotonin levels after the intervention. These results concludes the three types of exercise, especially combination of aerobic and resistance exercises, may be used as an alternative indirect therapy method and prevention of obesity.

Keywords: Obesity; Serotonin; Aerobic; Resistance; Combination Exercise.

1. Introduction

Obesity is defined as abnormal or excessive fat accumulation that can pose a risk to health[1]. Obesity occurs due to an imbalance between energy intake and expenditure[2],[3]. This is thought to be closely related to the hormone serotonin. Serotonin (5-HT) in coordination with the hypothalamus plays an important role in appetite control, eating behavior, as well as energy balance, and body weight in the central nervous system[4]. Serotonin interacts with endogenous orexigenic peptides (Neuropeptide Y/Agouti-associated proteins) and anorectics (melanocyte-stimulating hormone) in the hypothalamus. Serotonin integrates peripheral satiety

signals in solitary tract nuclei[5]. Low levels of serotonin in the body contribute to increasing the incidence of obesity[6].

The prevalence of obesity worldwide has been increasing since 1975[1]. World Health Organization states that by 2016, the obesity rate has tripled. More than 1.9 billion people are overweight, and 650 million of them are obese[1]. Meanwhile, in Indonesia, the prevalence of obesity at the age of 18 years is 21.8%. This figure increased in 2013 which was 14.8% and in 2007 which was at 10.5%[7]. If secular trends continue globally, it is estimated that 38% of the adult population will be overweight and another 20% will be obese[8]. Obesity is associated with an increased risk of almost every chronic condition such as diabetes, dyslipidemia, to poor mental health[9]. The impact on the risk of stroke, cardiovascular disease, certain cancers, and osteoarthritis is also quite significant[10]. According to data from the WHO, at least 2.8 million people die from being overweight or obese every year. In addition to health problems, obesity is also associated with unemployment, social disadvantage, and a decrease in socio-economic productivity, thus increasing the general economic burden[11]. The risk of obesity will be higher if serotonin levels decrease[12].

Research conducted by Hyunjin Park and colleagues showed that obese dogs had lower peripheral serotonin levels than non-obese dogs[12]. This research is in line with human studies conducted by Ibraheem and Hamid AL-Ardhi. Serotonin levels in obese subjects were much lower compared to the subjects with normal weight[6]. According to WHO[1], obesity can be reduced by engaging in regular physical activity and changing diet. Exercise with moderate-intensity can be used as a modality of obesity therapy[9],[13],[14],[15]. However, how this type of moderate-intensity exercise affects serotonin levels remains unclear.

Therefore, this study aims to compare the different effects of moderate-intensity exercise on serum serotonin levels in obese women aged 20-24 years with aerobic, resistance, and combination types of exercise intervention. The results of this study are expected to be a guide in the application of moderate-intensity exercise to serotonin levels in obese women for further research.

2. Materials and Methods

2.1 Experimental design

This research is a field experimental with a pre-test post-test control group design to see an increase in serum serotonin levels. The intervention will be carried out chronically for four weeks. A total of 24 women who met the inclusion criteria were divided randomly into four groups, namely K1 (n=6, control without any intervention), K2 (n=6, moderate-intensity aerobic exercise), K3 (n=6, moderate-intensity resistance exercise), K4 (n=6, moderate-intensity combination exercise). All research procedures have been approved by Komisi Etik Penelitian Kesehatan, Faculty of Medicine, Airlangga University, Surabaya (No: 283/EC/KEPK/FKUA/2021).

2.2 Protocol of exercise

The exercise program in this study used aerobic exercise, resistance training, and combination exercise. Aerobic exercise was carried out by running on a treadmill with an intensity of 60-70% HRmax, a volume of 40 minutes consisting of 5 minutes of warm-up, 30 minutes of core exercise, and 5 minutes of cooling down[9],[16]. Resistance training or weight training is carried out using gym equipment with an intensity of 60-70% 1RM, the volume of exercise is 5x12 repetitions consisting of 2x12 repetitions in a warm-

up session with a load intensity of <60% 1RM, and 3x12 repetitions of core training. Resistance training uses the circuit training method which is divided into two based on the focus of muscle exposure, namely:

1. Exercises for the upper body (pull-down machine, chest press machine, rowing machine, shoulder press machine, tricep machine).
2. Exercises for the lower body (leg press machine, abdominal machine, leg extension machine, leg curl machine, abductor machine).

Each day resistance training is focused on one muscle exposure (upper or lower body) and alternates on the following day. The combination exercise in this study is a combination of the two types of exercise (aerobic and resistance) with moderate intensity (60-70%) which is done alternately every day (only 1 type of exercise per day).

2.3 Data collection

Blood sampling (pretest) is extracted from the cubital vein as much as 3 cc. After the entire exercise intervention for 4 weeks, blood samples were taken 24 hours after the intervention (posttest) from the cubital vein as much as 3 cc carried out by UTD PMI Malang officers. The blood sample is centrifuged to separate red blood cells, plasma, and serum. The serum that has been obtained is then examined for serotonin hormone using the ELISA Kit method at the Laboratory of Physiology, Faculty of Medicine, Universitas Brawijaya.

2.4 Statistical analysis

The process of data analysis in this study used the software Statistical Package for Social Science (SPSS) version 16 (Chicago, IL, USA). The stages in the data analysis process to be able to answer the hypotheses that have been explained include descriptive test using a descriptive statistical test, test for normality using the Shapiro-Wilk test, homogeneity test using Levene test. Test the difference between two paired data using the Paired Sample T-Test, Different tests using One way-ANOVA and Tukey's honestly significant difference (HSD) post hoc test. However, if the data are not normally distributed, the non-parametric Kruskal-Wallis test is performed and continued by Mann-Whitney test. All statistical analyzes used a significant level ($p \leq 0.05$).

3. Results

Based on Table 1, obtained the descriptive of the subject characteristics analysis in each group.

Table 1. Descriptive of the subject characteristics analysis

Nu	Variable	K_1		K_2		K_3		K_4	
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
1	Age (years)	22.67	1.63	20.83	0.98	22.00	1.26	22.17	1.17
2	BW (kg)	82.80	7.40	77.95	5.46	80.82	8.43	81.20	10.86
3	BH (m)	1.59	0.07	1.56	0.05	1.56	0.06	1.57	0.05
4	BMI (kg/m^2)	32.70	3.31	32.12	3.22	32.97	3.01	33.23	2.40
5	FM (kg)	37.65	4.62	34.97	3.32	37.71	6.00	35.96	5.22
6	FFM (kg)	46.44	3.31	42.99	2.67	43.24	4.38	45.91	5.39
7	SMM (kg)	20.99	1.87	19.14	1.66	21.24	5.12	21.44	3.07
8	RHR (bpm)	78.83	10.19	74.00	6.36	82.83	9.09	80.50	6.92
9	SBP (mmHg)	117.00	9.27	110.83	9.58	116.50	9.81	114.33	12.29
10	DBP (mmHg)	80.17	8.89	80.00	7.13	82.17	6.74	83.00	6.07
11	SpO_2 (%)	98.00	1.10	96.50	4.23	98.33	0.82	97.67	1.50

Desciption: SD: Std. Deviation; BW: Body Weight, BH: Body Height, BMI: Body Mass Index, FM: Fat Mass, FFM: Fat-Free Mass, SMM: Skeletal Muscle Mass, RHR: Resting Heart Rate, SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure. K_1: Control Group, K_2: Aerobic Exercise Group, K_3: Resistance Exercise Group, K_4: Combination Exercise Group.

Based on Table 1, the results of One-way ANOVA analysis showed that the average data on the subject's characteristics in each group did not have a significant difference ($p \geq 0.05$). The results of pre-exercise and post exercise serum serotonin levels in the control, aerobic, resistance, and combination exercise groups are presented below (Figure 1).

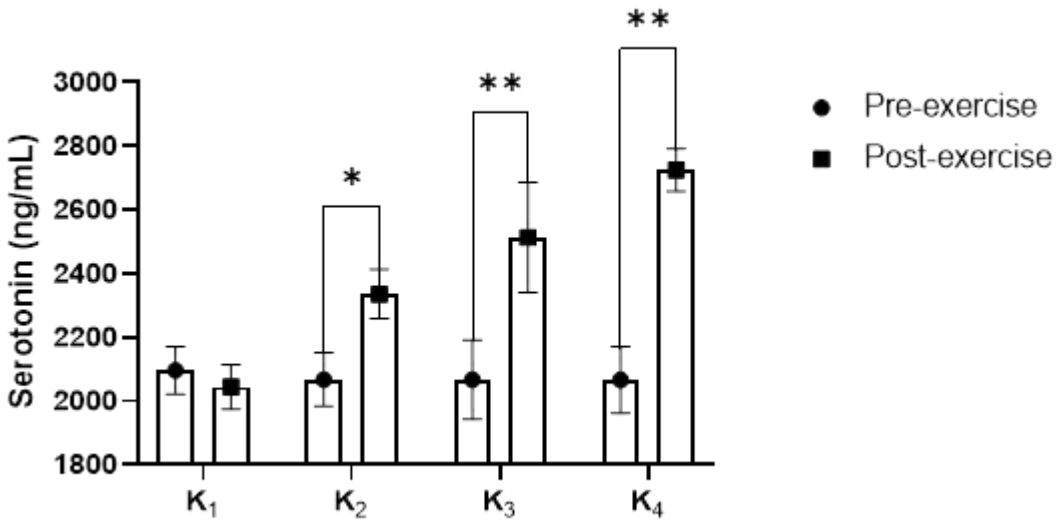

Figure 1. Pre-exercise and post-exercise serum serotonin levels in the four groups.

Note: K_1: control without any intervention; K_2: moderate-intensity aerobic exercise; K_3: moderate-intensity resistance exercise; K_4: moderate-intensity combination exercise. The data pesented as average of Mean. The significant level was considered (*) ($p \leq 0.05$), (**) ($p \leq 0.001$).

4. Discussion

Obesity in humans is associated with decreased serotonergic signaling. When serotonin levels are low, it can affect the homeostatic regulatory system in the brain that plays a role in balancing energy intake and expenditure. This system is in charge of regulating hunger, satiety, and the availability of integrated body nutrients to adapt eating behavior adequately to the current nutritional status. Brain failure to suppress food intake when the body's energy stores are sufficient results in overconsumption which can then lead to weight gain[17].

The results of this study indicate that aerobic, resistance, and combination exercise can increase serum serotonin levels in the blood. The pre-test conducted in the aerobic exercise intervention group showed an average serotonin level of 2067.59 ng/mL. Meanwhile, the post-test mean of serotonin levels showed an increase to 2335.89 ng/mL. This is in line with previous studies that showed an increase in serum serotonin levels[18],[19],[20]. When performing aerobic exercise, increased lipolysis results in increased compulsion of tryptophan from plasma binding proteins via free fatty acids. When the amount of tryptophan increases, the biosynthesis and release of serotonin into the blood also increases[21].

The results obtained from the analysis of serum serotonin levels in the resistance exercise

intervention showed an increase in the average value from 2067.59 ng/mL (pre-test) to 2513.57 ng/mL (post-test). These results indicate that moderate-intensity resistance training can increase serum serotonin levels in the study subjects. This is in line with previous studies that showed an increase in serum serotonin levels[22],[23]. Resistance exercise increases intrathoracic endothelial growth factors and can stimulate angiogenesis and has a direct effect on neurotrophic growth factors[22]. This leads to the reconstruction and repair of serotonin monoaminergic terminals[19]. This monoamine system mediates the increase in various brain functions induced by exercise, one of which is in regulating homeostatic homeostatic functions in the brain in reducing the prevalence of obesity[24].

The results of the analysis of serum serotonin levels after moderate intensity combined exercise showed an increase from 2066.40±104.34 ng/mL (pre-test) to 2725.77±67.16 ng/mL (post-test). It can be interpreted that combination exercise with moderate intensity can increase serum serotonin levels in research subjects. This is in line with previous studies that showed an increase in serum serotonin levels[25],[26]. Sequentially, the results of the analysis of differences or delta (Δ) values for each group from the lowest to the highest were the control group (51.28±60.44 ng/mL), the aerobic group (268.3±129.95 ng/mL), the resistance group (445.97±103.74). ng/mL), and the combination exercise group (659.36±84.07 ng/mL).

The increase in free L-tryptophan essential amino acids (free tryptophan) induced by exercise in the blood occurs due to the release of tryptophan from albumin caused by lipolysis of free fatty acids. The result is the absorption of free tryptophan is higher at the blood brain barrier. As a result, the biosynthesis of central serotonin becomes higher[27]. This is in line with the results of research that has been carried out where the three types of exercise interventions, both aerobic, resistance, and combination, were able to increase serum serotonin levels in subjects after exercise. Pietta-Dias hypothesized that by combining the benefits of aerobic and resistance training, combined exercise could result in a greater increase in serotonin levels[28]. In line with the Pietta-Dias hypothesis, this study also gives the same results.

There are not many studies that mention what the exact difference between the three mechanisms of exercise is in increasing serum serotonin levels. However, aerobic, resistance, and combination exercise appears to increase serum serotonin levels. Therefore, these three types of exercise, especially combination exercise, may be used as an alternative as a basis for using exercise as a therapeutic method and indirect obesity prevention.

5. Conclusion

The results of this study showed that aerobic, resistance, and combination exercise for four weeks with moderate intensity showed that the three groups experienced an increase in serum serotonin levels after the intervention. The results of this study conclude that the three types of exercise, especially the combination

of aerobic and resistance exercise, can be used as an alternative method of indirect therapy and obesity prevention.

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